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SPECIES COMPOSITION, CPUE AND LENGTH FREQUENCY OF OCEANIC SHARKS BASED ON OBSERVER DATA FROM THE INDONESIAN LONGLINE FISHERY IN THE INDIAN OCEAN

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Data about species composition, CPUE (catch number per 1000 hooks) of sharks and length frequency of dominant shark species caught in the Indian Ocean had been collected by scientific observers of the Research Institute for Tuna Fisheries data during 2005 - 2013. The total shark was caught 3,421 individuals comprised of 19 species. The most abundant species are blue shark and crocodile shark catched in all survey locations except west off Sumatra for of blue shark. CPUE average of blue shark is 1.55 (SD± 1.62) with values ranging between 0.37 and 13.83 sharks / 1000 hooks. Highest CPUE of blue shark were caught in latitude of 30^0 - 35^0 S. Length frequency distribution of blue shark showes 60 – 312 cmFL (SD± 32.41) males and 70 - 258 cmFL (SD± 31.03) females, with a domination of 195 cm and 205 cm sizes, respectively. Sex ratio of males and females of blue shark during this period is 1: 0.46, with a significant difference from the expected ratio is 1: 1 ($\chi 2$ = 27.5871, P <0.05). CPUE average of crocodile shark is 1.60 (SD ± 1.71) with values ranging between 0.37 and 20.13 sharks / 1000 hooks, and highest. CPUE were caught in latitude of 12^0 – 15^0 S. Length frequency distribution of crocodile shark shows 39-103 cmFL (SD±13.32) males and 37-106 cmFL (SD±17.08) females. It is dominated by 90 cmFL size, with sex ratio of males and females during this period is 1: 0,67, while a significant difference from the expected ratio is 1:1 ($\chi 2$ = 24,9958, P<0.05).

INTRODUCTION

Among oceanic migratory fishes, sharks is one of the less well known groups, in terms of biology and stock assessment. This fact seems to be resulted from their low economical value and consequently low research priority in most fisheries institutes (Megalofonou *et al*., 2005). Due to low fecundity, slow growth, a long time to reach maturity required, long life and a high risk of death at each age level, causing the shark

vulnerable to extinction due to high fishing pressure (Stevens et al., 2000; Fahmi & Dharmadi, 2005). Shark fisheries target is mainly driven by markets, such as fins, meat, skin and liver oil. Pelagic shark is almost always classified as by-catch, they often represent a significant, if it is not dominant founded then its classified as a portion of a vessel's catch. Although sharks have traditionally been discarded because of the relatively low ex-vessel value of their flesh, international markets growth and high prices paid for shark fins have been increased the retention rates of pelagic sharks, or at least of their fins (Camhi, 1999).

Fishing pressure can affect shark stock structure, diversity, and biological parameters, and in the worst of cases, could cause a species to become extinct (Stevens et al., 2000). Recent studies have revealed a significant reduction in abundance of large predatory fishes, including sharks, in the Indian Ocean (John and Varghese, 2009; Romanov et al., 2010). The purpose of this study is to examine the catch composition, CPUE and length structure of Blue shark and Crocodile shark caught as dominant shark by-catch which conducted by the Indonesian longline fleets in the Indian Ocean from 2005 to 2013.

MATERIALS AND METHODS

Data from tuna longline fishery in the Indian Ocean has collected by scientific observers from Research Institute for Tuna Fisheries during 2005 – 2013. Those data for the analysis can be seen in Figure 1. During this period, the total number of trips, operations and observed hooks were 94 trips, 2,268 operations and 3,264,588 hooks, respectively.

The data informing a fishing position, date, the number of hooks used, catch number by species, Frok length (cmFL) and sex of each shark. We analyses the

composition of by-catch species, species composition, and average of nominal CPUE (catch number per 1000 hooks). It is found that blue shark (*Prionace glauca*) and crocodile shark (*Pseudocarcharias kamoharai*) are a dominant species. The CPUE distribution, length frequency, and sex ratio of blue shark and crocodile shark are also subject to discussed.

RESULTS AND DISCUSSION

The proportion of sharks among by-catch species

Figure 2 shows the species composition of by-catch species except tuna based on surveys data. The by-catch species were classified into four categories, i.e. sharks, rays, billfish and finfish. It shows that Sharks occupied 2.74 ~ 19.01 % of total of by-catch in each year.

Species composition of sharks

During 2005 – 2013 3,421 individuals were caught, comprised of 19 shark species (including unidentified shark, thresher shark and hammerhead shark), see Table 1. The composition of the catches consists of Blue shark (*Prionace glauca*) 50.85 %, Crocodile shark (*Pseudocarcharias kamoharai*) 32.17%, Mako shark (*Isurus oxyrinchus*) 3.12%, Silky shark (*Carcharhinus falciformis*) and Spinner shark (*Carcharhinus brevipinna*) 2.36% and 2.13% respectively, whereas for other species of below 2%.

According to White et al. (2012), in Tanjung Luar (East Lombok) longline shark fishery, a total of 36 species were recorded from both longline types (drift and bottom longline), comprising 31 shark species and 5 ray species. *Carcharhinus falciformis* is so far the most abundant species landed by pelagic drift longlines in all years surveyed, whereas the most abundant species (by-number), recorded by bottom longline vessels, were *Carcharhinus amblyrhynchos, C. obscurus and C. sorrah*. By-weight, *C. obscurus* was

typically the most abundant species, with *C. sorrah* contributing much less due to the much smaller of average size of the species.

Dominant shark species in Indonesia Tuna Longline Fisheries

1. Blue shark (*Prionace glauca*)

Blue shark, *Prionace glauca*, is the most abundant among sharks and widely distribution in the world, ranging from the eastern Atlantic to the western Pacific. In Indonesian seas, commonly found in the Indian Ocean from west of Sumatra to south of Nusa Tenggara. Sometimes is also found in South China Sea and the Banda Sea (Fahmi and Dharmadi, 2013). However, this species is highly targeted in the fin trade market and is frequently caught as a by-catch in the longline and gillnet fisheries (Mendonça, 2009).

Based on surveys data collected in the Indian Ocean, blue shark caught in almost all fishing area, except in west off Sumatra, see Figure 3. CPUE average of 1.55 (SD ± 1.62) with values ranging between 0.37 and 13.83 sharks / 1000 hooks. Highest CPUE of blue shark were caught in latitude of 30^0 - 35^0 S, see Figure 4. In contrast to Tanjung Luar shark fisheries, *C. Falciformis* is consistent with the presence of large number. This is likely related to the area being fished or the depth being fished. This fishery occurs generally is relatively close to the land (thus mainly offshore rather than oceanic), whereas in tuna longline catches where blue shark typically represents the vast majority of the catch, and blue shark is an oceanic species which have lower proportion were recorded (White et al., 2012).

Length frequency distribution of blue shark shows 60 – 312 cmFL (SD± 32.41) males and 70 - 258 cmFL (SD± 31.03) females. It is dominated by the size of 195 cm and 205 cm, respectively (see Figure 6). According to Executive summary (IOTC, 2013), information of size at maturity (L_{50}) of the blue shark is not available for the Indian Ocean. While in the Atlantic informed that 182–218 cm TL for males, and 173–221 cm TL is for

females. In the South Pacific: 229–235 cm TL for males and 205–229 cm TL for females. White et al. (2006), states blue shark can attains size at least 383 cm, both sexes mature at 210-220 cm and born at 35-44 cm. Overall sex ratio between males and females of blue shark during this period is 1: 0.46 and it showed a significant difference from the expected ratio is 1: 1 ($\chi 2 = 27.5871$, $P < 0.05$).

2. Crocodile Shark (Pseudocarcharias kamoharai)

Crocodile shark, *Pseudocarcharias kamoharai* is is a small lamnoid shark which is an offshore inhabitant in the world's oceans. Although the species is an abundant shark which taken in some pelagic longline fisheries. Limited biological information and catch data is available. The lack of information is attributed to its low commercial value and relatively rare encounters in commercial fisheries during the last century (Romanov et al., 2008).

Based on the surveys data, crocodile shark caught in all areas which have a high abundance in near shore seas, see Figure 5. CPUE average of 1.59 (SD ± 1.71) with values ranging between 0.37 and 20.13 sharks / 1000 hooks. Highest CPUE of crocodile shark were caught in latitude of $12^0 – 15^0$ S. Longliners in the Indian Ocean had been reported the highest catch rates is a crocodile shark, and they are also informed that one of the most frequently caught species in the Western Australian longline fishery (Ward et al., 2008).

Length frequency distribution of crocodile shark shows 39-103 cmFL (SD±13.32) males and 37-106 cmFL (SD±17.08) females, where mature males of 74 centimetres and mature females of 89 centimetres have been reported (Compagno, 1984). The crocodile shark males and females is dominated by 90 cmFL size, see Figure 7. According to Ariz et al. (2007), from the observers on board the Spanish longliners, it is reported that crocodile shark have a Mean length and length range of males and females are 88, 70-100 cmFL and

90, 69-102 cmFL respectively. Overall sex ratio between males and females during the period is 1: 0.67, and it showed a significant difference from the expected ratio is 1: 1 ($\chi 2$ = 24,9958, P<0.05). Romanov et al. (2008), stated that depending on the fishery, catches of crocodile shark varied by sex. In the Japanese Pacific yellowfin ($p < 0.002$) and US Pacific tuna fisheries ($p < 0.001$), there are a significantly more male crocodile shark have been reported, whereas there are a significantly more females in US Atlantic swordfish ($p < 0.001$) and Japanese southern bluefin ($p < 0.004$) fisheries. Overall, a male crocodile shark is outnumbered females ($p < 0.001$).

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REFERENCES

Ariz, J., A. Delgado de Molina, Mª L. Ramos & J.C. Santana. 2007. Length-weight relationships, conversion factors and analyses of sex-ratio, by length-range, for several species of pelagic sharks caught in experimental cruises on board Spanish longliners in the South Western Indian Ocean during 2005. IOTC-2007-WPEB-04.

Camhi, M. 1999. Sharks on the Line II: An Analysis of Pacific State Shark Fisheries. Living Oceans Program, National Audubon Society, Islip, NY.116 pp.

Compagno. L.J.V. 1984. FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes. FAO Fisheries Synopsis No. 125 Vol. 4(1): 1–249.

Fahmi & Dharmadi. 2005. Status Perikanan Hiu dan Aspek Pengelolaannya. Oseana. 30 (1): 1 - 8.

Fahmi & Dharmadi. 2013. Review Status of Shark Fisheries in Indonesia. Marine and Aquatic Resources Conservation. Directorate General Marine Coastal and Small Islands. Ministry of Marine Affairs and fisheries. 179 pp .

IOTC. 2013. DRAFT: EXECUTIVE SUMMARY: Blue shark. Status of the Indian Ocean blue shark (BSH: Prionace glauca).IOTC–2013–SC16–ES17[E].

John. M. E & B.C. Varghese. 2009. Decline in CPUE of Oceanic Sharks in the Indian EEZ : Urgent Need for Precautionary Approach. IOTC-2009-WPEB-17.

Megalofonou, P., Damalas, D., & Yannopoulos, C. 2005. Composition and Abundance of Pelagic Shark By-catch in The Eastern Mediterranean Sea . Cybium 29(2): 135-140.

Mendonça. 2009. Diet of the blue shark, Prionace glauca, in the Northeast Atlantic. Thesis. Department of Biology Faculty of Sciences, Porto university.

Romanov. E.V., P. Ward., J.C. Levesque & E. Lawrence. 2008. Preliminary analysis of crocodile shark (*Pseudocarcharias kamoharai*) distribution and abundance trends in pelagic longline fisheries. Paper presented at IOTC Working Party on Environment and Bycatch (WPEB) Bangkok, Thailand 20-22 October, 2008. IOTC-2008-WPEB-09.

Romanov E., Bach P., Rabearisoa N., Rabehagasoa N., Filippi T., & Romanova N. 2010. Pelagic elasmobranch diversity and abundance in the Indian Ocean: an analysis of long-term trends from research and fisheries longline data. IOTC Working Party on Ecosystems and Bycatch (WPEB) Victoria, Seychelles. IOTC-2010-WPEB-16.

Stevens. J. D., R. Bonfil, N. K. Dulvy, & P. A. Walker. 2000. The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. ICES Journal of Marine Science, 57: 476–494.

Ward. P., Evgeny Romanov., & Emma Lawrence. 2008. Appendix A. The global distribution of crocodile shark (Pseudocarcharius kamoharai) with notes on the sex and size composition of pelagic longline catches. In Effects of fishing on high risk bycatch species in the Western Tuna and Billfish Fishery. R2004/1198 /2008. Final Report to the Australian Fisheries Management Authority. Bureau of Rural Sciences. Canberra.

White, W.T., Last, P.R., Stevens, J.D., Yearsley, G.K., Fahmi and Dharmadi. 2006. Economically Important Sharks and Rays of Indonesia. Australian Centre for International Agricultural Research. 329pp.

White, W.T., Dichmont, C., Purwanto, Nurhakim, S., Dharmadi, West, R.J., Buckworth, R., Sadiyah, L., Faizah, R., Sulaiman, P.S. & Sumiono, B. 2012. Tanjung Luar (East Lombok) Longline Shark Fishery. Report prepared for ACIAR Project FIS/2006/142, Developing new assessment and policy frameworks for Indonesia's marine fisheries, including the control and management of Illegal, Unregulated and Unreported (IUU) Fishing. Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia. 53 pp.

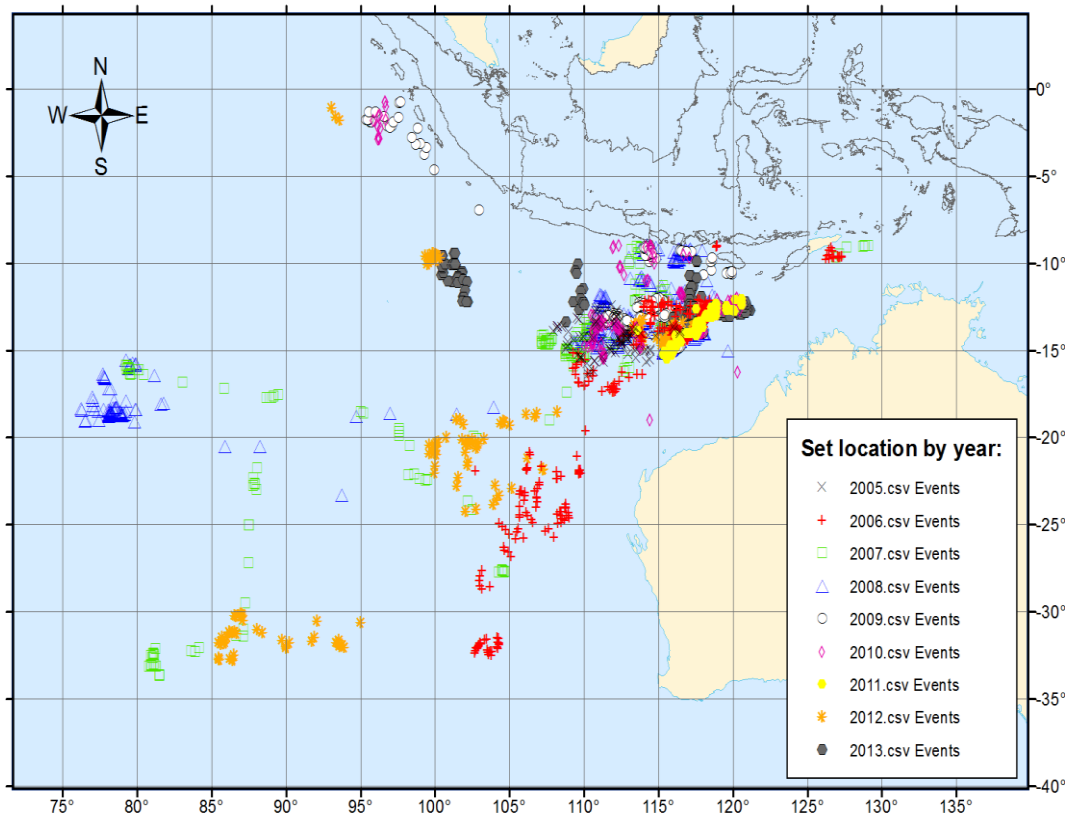

Figure 1. Setting positions of Indonesia tuna longline from scientific observers in the Indian Ocean during 2005 - 2013.

Table 1. Shark species caught by Indonesia tuna longline fishery from 2005 to 2013.

CODE	Species	Year									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	%
PTH	Alopias pelagicus	1	8	5	9	2	2	16	3	1	1,37
BTH	Alopias superciliosus	1	20	4	1	1	0	1	2	1	0,90
CCB	Carcharhinus brevipinna	3	16	33	6	10	0	0	1	4	2,13
FAL	Carcharhinus falciformis	0	36	7	2	21	15	0	0	0	2,36
OCS	Carcharhinus longimanus	0	2	14	4	10	14	7	4	2	1,66
CCE	Carcharhinus leucas	1	5	1	0	0	0	0	0	0	0,20
CCL	Carcharhinus limbatus	2	0	0	0	0	0	0	0	0	0,06
CCP	Carcharhinus plumbeus	4	0	0	0	0	0	0	0	0	0,12
SMA	Isurus oxyrinchus	4	21	35	17	12	4	0	11	3	3,12
LMA	Isurus paucus	1	1	4	14	7	0	0	1	0	0,82

BSH	Prionace glauca	59	473	427	221	53	80	2	381	44	50,85
PSK	Pseudocarcharias kamoharai	46	156	100	140	69	305	63	157	63	32,17
SPL	Sphyrna lewini	0	1	6	10	3	1	1	2	1	0,73
SPZ	Sphyrna zygaena	0	0	3	0	3	0	0	0	0	0,18
TIG	Galeocerdo cuvier	0	0	3	4	1	0	0	0	1	0,26
ZSQ	Zemeus squamulosus	0	0	1	0	0	3	0	3	1	0,23
SPY	Sphyrnidae	1	12	0	0	0	0	0	0	0	0,38
THR	Thresher sharks nei	10	0	8	4	20	0	0	0	0	1,23
SHK	Shark nei	19	0	0	22	1	0	0	0	0	1,23
	Total	152	751	651	454	213	424	90	565	121	100

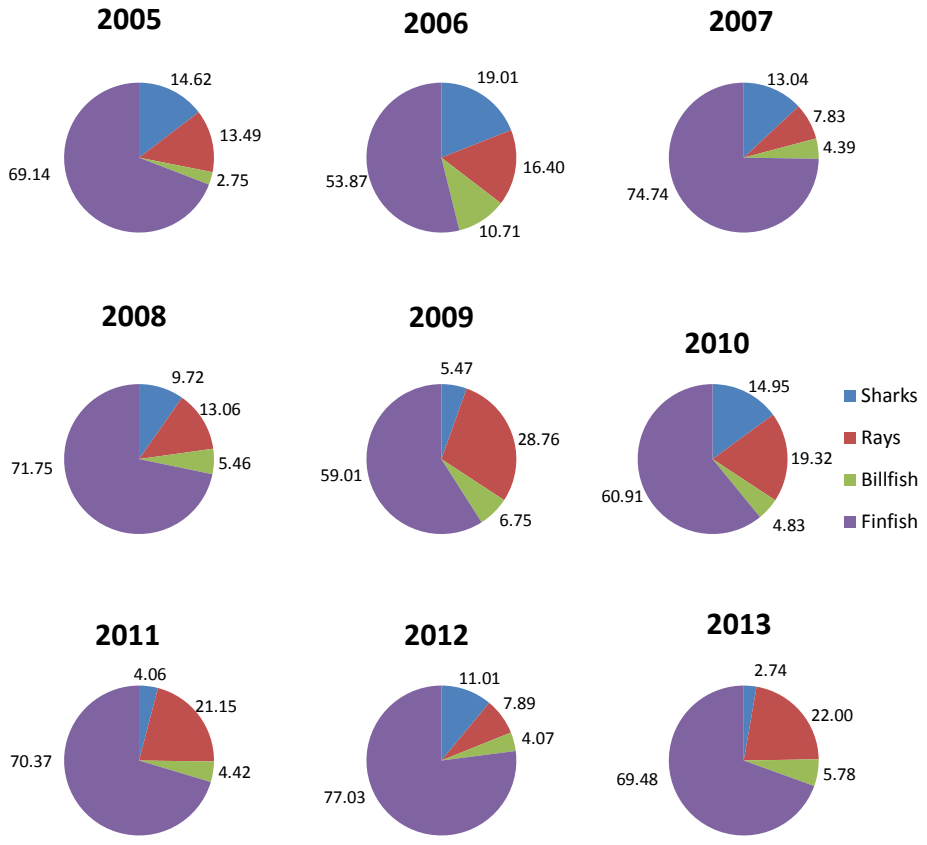

Figure 2. The composition of by-catch species groups caught in Indian Ocean by Indonesian tuna longline fleets.

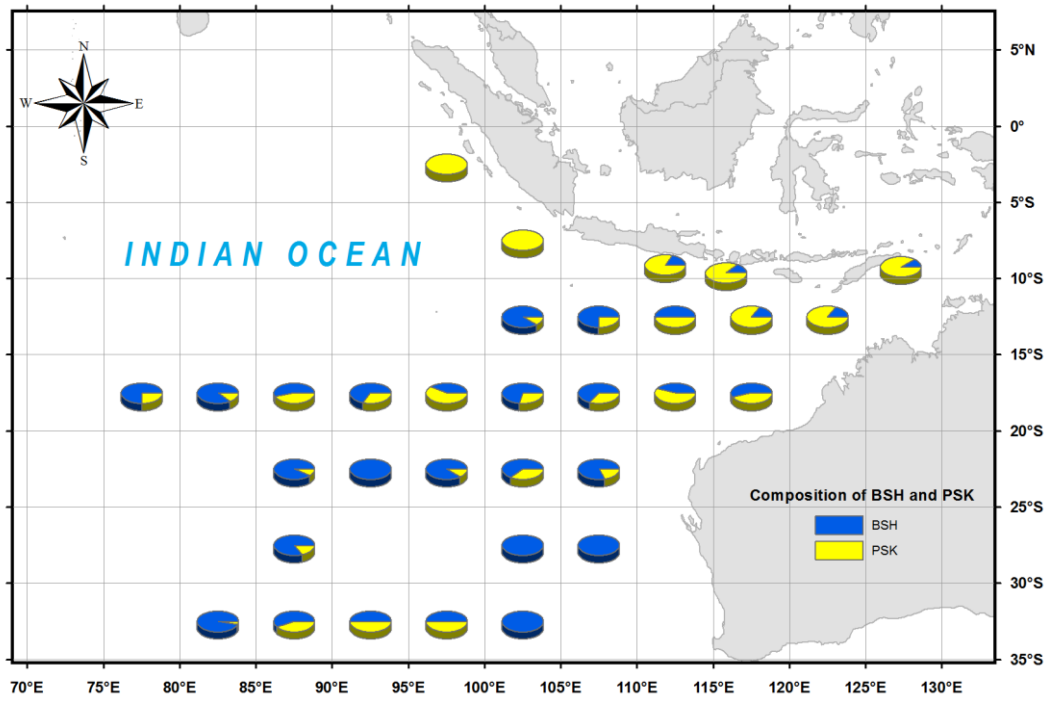

Figure 3. CPUE composition of Blue shark and Crodile Shark by Indonesian tuna longline fleets during 2005 – 2013, shown in 5 x 5 degrees grid.

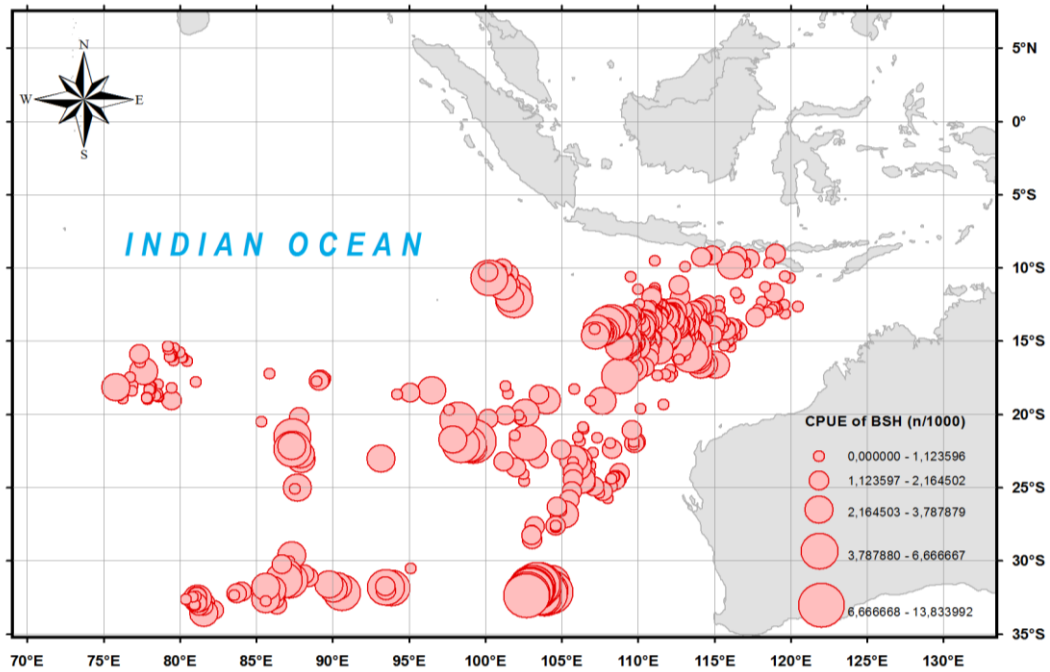

Figure 4. CPUE distribution of Blue shark by Indonesian tuna longline fleets during 2005 – 2013.

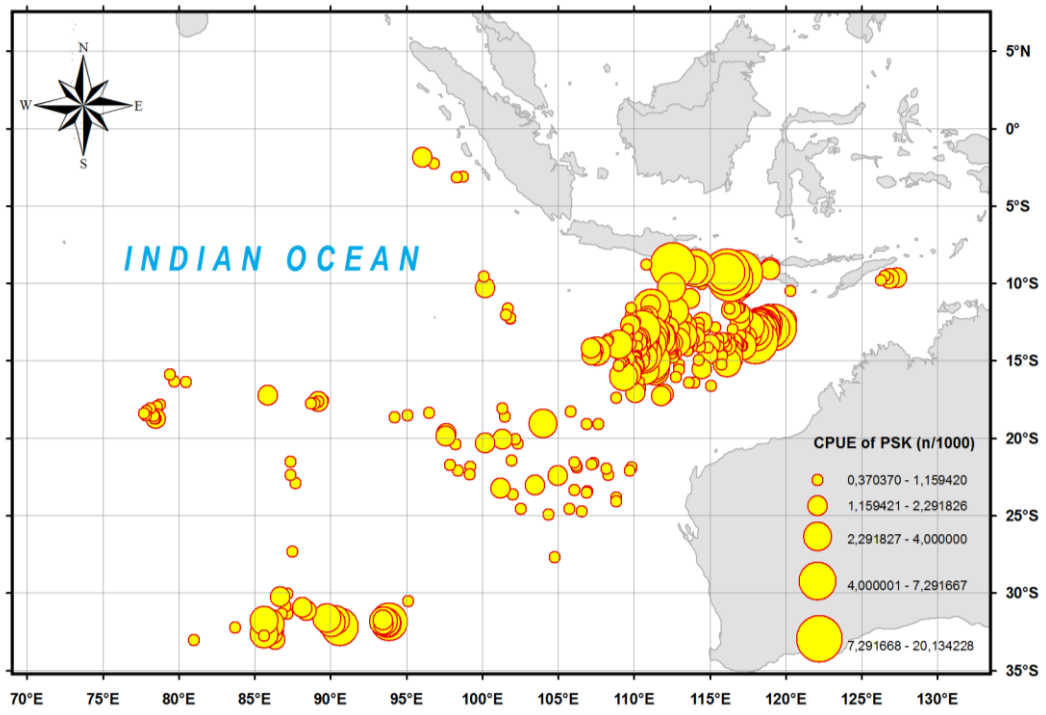

Figure 5 . CPUE distribution of Crocodile shark by Indonesian tuna longline fleets during 2005 – 2013.

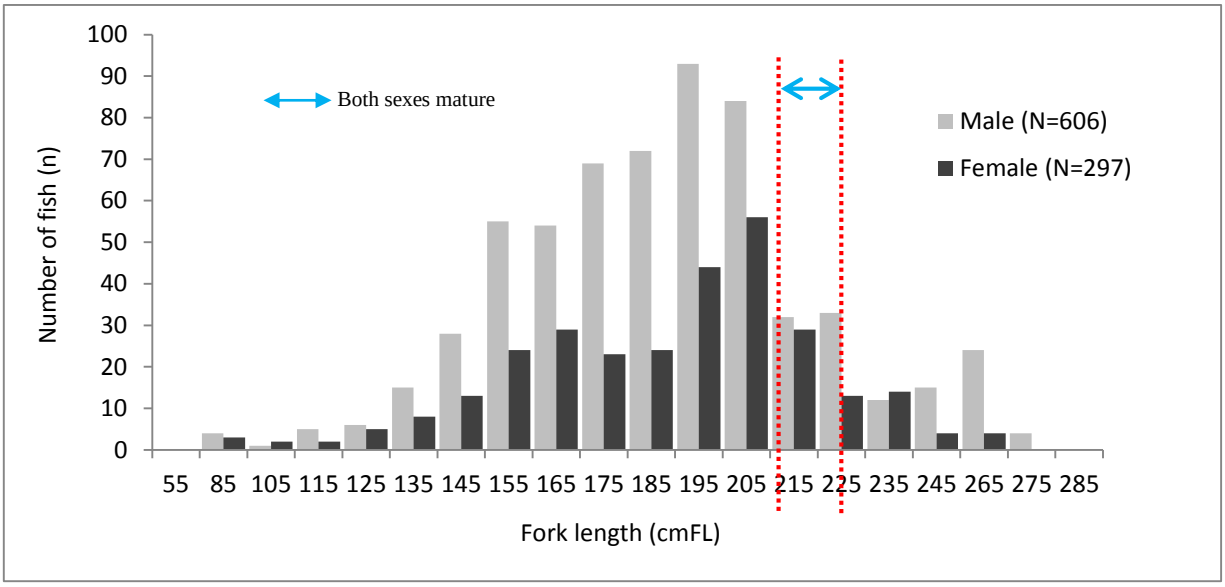

Figure 6. Length distribution of male and female Blue shark by Indonesian tuna longline fleets during 2005 – 2013.

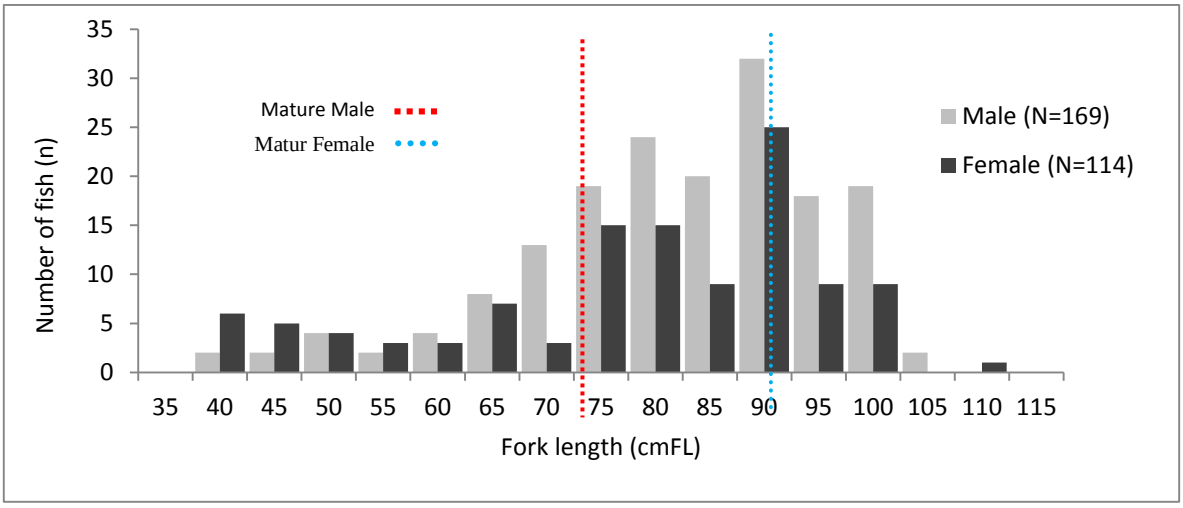

Figure 7. Length distribution of male and female Crocodile shark by Indonesian tuna longline fleets during 2005 – 2013.